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Absolute standardisation of ^{155}Tb and precision nuclear data determination: accelerating clinical uptake of novel radioisotopes

Introduction:

Interest in the element terbium (Tb) for medical application has grown recently [1]. Four Tb isotopes have been identified with the potential to provide unique theragnostic treatment strategies which combine cancer therapy with diagnostic imaging. The isotopes ^{155}Tb and ^{152}Tb can provide SPECT and PET imaging respectively [2], whilst ^{161}Tb can be used for beta– therapy [3] and ^{149}Tb for alpha therapy [4][5]. Using a combination of these isotopes as labels for radio-pharmaceuticals can provide both pre-therapy diagnostic imaging and post-therapy dosimetry and treatment optimisation using the same delivery vector. In order to validate the use of these isotopes for patient treatments extensive pre-clinical studies [1] are required to provide the foundation for future clinical trials.

The determination of administered activity, traceable to a primary standard of radioactivity is essential for all radio-pharmaceuticals. Accurate nuclear data measurements combined with a primary activity standardisation underpin the clinical use of any radioisotopes.

Methods:
Samples of ^{155}Tb were collected with the prototype MEDICIS collection chamber at ISOLDE. At NPL, pseudo-isobaric ^{139}Ce impurities have removed from the dissolved target using ion-exchange and extraction chromatography separation procedures. A new primary activity standardisation was performed using digital coincidence counting [6] and liquid scintillation techniques. Calibration factors for the NPL secondary standard ionisation chamber were also determined. Gamma spectrometry measurements of the ^{155}Tb decay scheme and half-life were also performed.

Results:
After purification of the sample a detection limit for ^{139}Ce of < 0.021 % is reported. An absolute activity standardisation for ^{155}Tb will be reported. Revised gamma-ray intensities for transitions in ^{155}Tb are reported with significant variations from the ENSDF evaluation [7]. A new half-life measurement is also reported.

The impact of these revised measurements on the clinical use of ^{155}Tb will be highlighted.

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